CLAIMS

1. A vehicle thermal system, comprising:

a reconfigurable refrigerant-based automotive air conditioning system for creating at least one of a plurality of possible refrigerant loops; and

a bidirectional orifice separator within said at least one of said plurality of possible refrigerant loops.

2. A vehicle thermal system according to claim 1 further comprising:

a thermostatic expansion valve; and

a first heat exchanger, said bi-directional orifice separator reconfigurable to fluidically couple said thermostatic expansion valve to said heat exchanger.

3. A vehicle thermal system according to claim 2 further comprising:

a second heat exchanger, said bidirectional orifice separator reconfigurable to fluidically couple said thermostatic expansion valve to said second heat exchanger.

4. A vehicle thermal system according to claim 3 wherein said bidirectional orifice separator comprises a bidirectional orifice tube, said bidirectional orifice separator operable to expand refrigerant flowing through the bidirectional orifice tube when said bidirectional orifice separator is fluidically connected to both said first heat exchanger and said second heat exchanger.

5. A vehicle thermal system according to claim 1 further comprising:

a reconfigurable liquid-coolant-based automotive heating system for creating at least one of a plurality of possible coolant loops; and

a bi-fluidic heat exchanger thermally coupling said air conditioning system to said heating system.

6. A vehicle thermal system of claim 5 further comprising an HVAC unit for thermally coupling said air conditioning subsystem to said heating system, said HVAC unit comprising:

an evaporator having refrigerant channels thermally connected to ventilation air;

a heater core having coolant channels thermally connected to ventilation air; and

a blower for blowing ventilation air adjacent to said evaporator and adjacent to said heater core for transferring heat from the ventilation air into said refrigerant channels, transferring heat from said refrigerant channels into said ventilation air adjacent to said coolant channels through the bi-fluidic heat exchanger, and transferring heat from said coolant channels into said heater core.

7. A thermal system for an electrically-powered vehicle having a power train, the thermal system comprising:

a reconfigurable refrigerant-based automotive air conditioning system for creating at least one of a plurality of possible refrigerant loops, said refrigerant-based automotive air conditioning subsystem comprising:

an evaporator having refrigerant channels thermally connected to ventilation air and configurable to receive previously cooled refrigerant, said evaporator operable to cool and dehumidify the flow of ventilation air; and

a bi-fluidic heat exchanger having refrigerant channels thermally coupled to coolant channels;

a bidirectional orifice separator within said at least one of said plurality of possible refrigerant loops;

a compressor;

an outside air heat exchanger;

an accumulator fluidically coupled to an input of said compressor;

a 4-way reversing valve configured to receive compressed refrigerant from said compressor and operable to discharge compressed refrigerant into a selected one of the bi-fluidic heat exchanger and the outside air heat exchanger and to receive refrigerant from the non-selected one of the bi-fluidic heat exchanger and the outside air heat exchanger to discharge refrigerant from the non-selected one of the bi-fluidic heat exchanger and the outside air heat exchanger to said accumulator; and

a reconfigurable liquid-coolant-based automotive heating system for creating at least one loop of said plurality of the coolant loops, wherein the refrigerant-based automotive air conditioning system and the liquid-coolant-based automotive heating system are configured to operate concurrently and in concert.

8. A thermal system according to claim 7 wherein said bidirectional orifice separator comprises:

a first shutoff valve fluidically coupled to said bi-fluidic heat exchanger;

a second shutoff valve fluidically coupled to said outside heat exchanger;

a bidirectional orifice tube coupled in series between said first shutoff valve and said second shutoff valve for expanding refrigerant when said first and second shutoff valves are open.

9. A thermal system according to claim 8 wherein said heating system comprises:

a heater core; and

a 3-way valve for transferring coolant to said heater core.

10. A thermal system according to claim 9 wherein said evaporator is configured to receive refrigerant previously cooled in a bi-fluidic heat exchanger, said bidirectional orifice separator including said first shutoff valve, configured to permit flow of refrigerant into said bidirectional orifice separator, said second shutoff valve configured to prevent flow of refrigerant into the bidirectional orifice separator, and said 4-way valve configured to select the bi-fluidic heat exchanger, said refrigerant-based automotive air conditioning system thus configured comprising a first refrigerant loop of said plurality of refrigerant loops operable to remove heat from ventilation air during dehumidification and transfer heat through the bi-fluidic heat exchanger to a coolant loop of the coolant-based heating system.

11. A thermal system according to claim 10, wherein said coolant loop of the plurality of coolant loops comprises a first coolant loop coupled in series between said heater core and said bi-fluidic heat exchanger, said 3-way valve configured to discharge coolant to said heater core, and said heater core configured to receive coolant from said bi-fluidic heat exchanger.

12. A reconfigurable vehicle thermal control system, comprising:

a reconfigurable refrigerant-based air conditioning system for creating a plurality of refrigerant loops, each said loop including a bidirectional orifice separator;

a reconfigurable coolant-based heating system for creating a plurality of coolant loops; and

a bidirectional fluidic heat exchanger configurable to transfer heat between at least one of said plurality of refrigerant loops and at least one of said plurality of coolant loops.

13. A system according to claim 12, wherein said at least one refrigerant loop comprises:

an outside air heat exchanger; and

a 4-way reversing valve configurable to discharge pressurized refrigerant into one of an outside air heat exchanger and said bi-fluidic heat

exchanger; said bidirectional orifice separator fluidically connecting said outside air heat exchanger to the bi-fluidic heat exchanger.

14. A system according to claim 12, wherein said coolant-based heating system comprises:

a plurality of power train components; and

a coolant-based reconfigurable power train thermal control section comprising a heating loop and a cooling loop, said power train thermal control section configurable to contemporaneously heat selected ones of said plurality of power train components and to cool-non-selected power train components.

15. A system of claim 12 further comprising at least one dedicated coolant heater.

16. A bidirectional orifice separator for use in a vehicular thermal control system, the bidirectional orifice separator comprising:

a bidirectional orifice tube;

a first check valve having an input channel and an output channel;

a second check valve having an input channel and an output channel, wherein

said bidirectional orifice tube is connected in series between input channels of said first and second check valves;

a receiver including a refrigerant output port, operable to discharge refrigerant received from output channels from at least one of said first check valve and said second check valve.

17. A bidirectional orifice separator according to claim 16 further comprising a receiver fluidically coupled to said output channels of said first and second check valves and to said refrigerant output port.

18. A bidirectional orifice separator according to claim 17, wherein said vehicular thermal system comprises first and second heat exchangers, said bidirectional orifice separator further comprising:

a first transfer valve fluidically coupled in series between said first

heat exchanger and a first end of said bidirectional orifice tube; and

a second transfer valve fluidically coupled in series between said second heat exchanger and a second end of said bidirectional orifice tube; said first and second transfer valves configurable to control refrigerant flow into said bidirectional orifice separator.

19. A bidirectional orifice separator according to claim 18 wherein said first check valve is configurable to receive expanded refrigerant discharged from a first end of the orifice tube.

20. A bidirectional orifice separator according to claim 18 wherein said first check valve is configurable to receive condensed refrigerant from said first heat exchanger.

21. A bidirectional orifice separator according to claim 20 wherein said first check valve is coupled to said receiver and discharges refrigerant into said receiver.

22. A bidirectional orifice separator according to claim 18 wherein said second check valve is configurable to receive expanded refrigerant discharged from a second end of the orifice tube.

23. A bidirectional orifice separator according to claim 22 wherein said second check valve is configurable to receive condensed refrigerant from said second heat exchanger.

24. A bidirectional orifice separator according to claim 23 wherein said second check valve discharges refrigerant into said receiver.

25. A bidirectional orifice separator according to claim 24 wherein said vehicular thermal system further comprises a compressor, said bidirectional orifice separator further comprising a 4-way reversing valve operable to direct refrigerant from said compressor to one of said first heat exchanger and said second heat exchanger.

26. A bidirectional orifice separator according to claim 25 further comprising a controller for controlling said first and second transfer valves and said 4-way reversing valve.